



An Analysis of innovative postgraduate training system of international tutor auxiliary education system - taking material Science as an example

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ABSTRACT

This article introduces some practices and explorations of the innovative postgraduate training system of the School of Materials and Chemistry of the University of Shanghai for Science and Technology through the international tutor assistant system. The purpose of the "assistant teaching system" of international tutors and the "bishopric" teaching model of domestic tutors is to produce a synergistic effect of "1+1>2". Discuss the method of academic tutor-international joint training to allow students to obtain international education, to cultivate students' all-round thinking, broaden academic international vision, and enhance international competitiveness. Provide reference for the educational reform of how to improve the scientific research and innovation ability of materials science students in the background of the new era of talent work and the construction of a talented country.

1. INTRODUCTION

In 2021, General Secretary Xi Jinping emphasized in an important speech at the Central Talent Work Conference that we must make great efforts to cultivate, introduce and make good use of talents in all aspects. This important exposition of General Secretary Xi Jinping has pointed out the way forward and provided fundamental follow-up for the talent work in the new era and the building of a talented country. The speech clearly pointed out that cultivating innovative talents is undoubtedly the most powerful means to build a country with talents. Colleges and universities are the cradle of cultivating innovative talents for the country; they are the gathering place of national innovative University of Shanghai for Science and Technology,talents; they are the important guarantee for the development of national science, technology, and economy; they are the leaders of national cultural heritage and innovation [1-5].

In recent years, with the rapid economic growth of the country, the investment in education has continued to increase, and the development of education has been vigorously developed. my country's higher education has developed rapidly, and college education has entered a new period of development. The overall level of many disciplines in China has been greatly improved. Judging from the ESI rankings of national universities in July 2021, a total of 342 universities in mainland China have subjects in the top 1% of the world. National education and economic development, national prosperity and national progress are in the same direction. Therefore, the improvement of the level of disciplines in turn puts forward higher requirements for postgraduate

education. Innovative postgraduate academic literacy has become a constraint on the sustainable development of materials disciplines and the realization of world-class goals. One of the key factors. At present, the number of graduate students in my country has exceeded 3 million, and the scale of graduate students is the largest in the world. However, the academic literacy of innovative graduate students is still a relatively weak link in the higher education system, and there is still a certain gap with the international high level. For this reason, a large number of graduate students choose to go to countries with a higher level of graduate education for further study in order to improve their academic literacy [6-8].

In view of the lack of "internationalization" of postgraduate education in my country and the lack of international academic communication capabilities of postgraduates, in addition to the existing full-English postgraduate courses in the training plan, domestic and foreign English academic forums, and all-English academic achievements poster exhibitions and other international education methods, Increase the teaching methods of the international tutor assistance system, provide graduate students with an international teaching environment and academic atmosphere, and further improve the academic ability and international vision of innovative graduate students.

2. INTERNATIONAL EDUCATION IS AN IMPORTANT PART OF THE INNOVATIVE POSTGRADUATE TRAINING SYSTEM.

To be at the forefront of the world in terms of technological innovation, the country must discover talents in innovative practice, cultivate talents in innovative activities, and condense talents in innovative undertakings. It must vigorously cultivate large-scale, reasonable structure, and high-quality innovative scientific and technological talents. With the rapid economic and social development, my country's policy support for building a science and technology power has continued to increase, attracting more and more global cutting-edge talents [9-10].

The joining of high-level foreign talents to China's top universities is an important part of the innovative postgraduate training system, and it is also regarded as one of the important events in the internationalization of the faculty of universities. In addition to the faculty of high-level professors such as Zhuang Songlin, Wang Yingluo, Zheng Ping, Yan Chuliang, academicians of the Chinese Academy of Engineering, the University of Shanghai for Science and Technology also has foreign academicians of the Chinese Academy of Engineering Gu Min and Professor Fujishima Akira who joined the University of Shanghai for Science and Technology full-time in 2019 and 2021. This is a typical representative of our school's systematic improvement of the international level of the teaching staff. With the deepening of economic globalization, the competition for talents among countries will become more intense, and the transnational flow of talents will inevitably become more frequent. In the foreseeable future, the continuous introduction of high-level foreign talents will still be an important measure for our country to realize the building of a powerful science and technology country.

The establishment of international cooperation in running schools is also one of the important measures for international education. As of May 2020, the school has established two Sino-foreign cooperative education institutions, the Sino-British International College and the Sino-German International College. It has established cooperative relations with 172 institutions of higher learning in more than 31 countries and regions, including the United States, Britain, Germany, Canada, and Australia, and has nearly 1,000 international students. The School of Materials and Chemistry has established long-term cooperative relations with many universities and research institutions in Germany, the United States, the United Kingdom, Australia, Japan, South Korea and

other countries. Every year, a large number of foreign students come to our school to study for bachelor, master, doctorate or exchange students, and a large number of undergraduates and graduate students from our school go to the above-mentioned universities and institutions for study and exchange. It also introduced James C. Williams, an academican of the American Academy of Engineering, and Rodney R. Boyer, a famous American aerospace material expert, as external experts to build the Large Aircraft Additive Manufacturing Research Institute, which is the most complete, most advanced, and most complete 3D printer equipment in China [11-12]. One of the research institutions of additive manufacturing. Based on the domestic and international perspective, focusing on the application of additive manufacturing in the fields of aerospace, new energy, and medical care, we will cultivate international-level innovative materials science graduate students.

3. EXPLORING THE MODEL AND MECHANISM OF CULTIVATING HIGH-END INNOVATIVE GRADUATE STUDENTS

As the new era advances a higher level of opening to the outside world and the requirements for building a strong country in science and technology, how to build a talent system with global competitiveness and systematically improve the international level of the teaching staff to meet the needs of economic and social development should be more discussed. Although the full-time participation of high-level foreign talents in Chinese universities mentioned in the previous article is regarded as one of the important events of the internationalization of the teaching staff of universities, there are still some problems, such as the extremely small number of such full-time teachers and researchers, and the older Nobel Prize winner The input-output ratio of coming to China is low. Therefore, it is necessary to explore the model and mechanism of cultivating high-end innovative graduate students.

The training system of graduate students is different from that of undergraduates. The cultivation of their scientific research and innovation ability mainly depends on the direct guidance of their supervisors. Therefore, the traditional "one-to-one" teaching and training model makes the training level of graduate students directly related to the supervisor's scientific research and innovation ability. limitation. So how to make the team of university graduate tutors have an international scientific research vision and a certain degree of international cooperation and communication capabilities? On the one hand, it is necessary to increase the intensity of the introduction of talents returning from studying abroad, and on the other hand, it is necessary to increase the support for teachers to study abroad. However, the number of teachers is large, and the base is large. Therefore, the opportunities and scope of international exchanges for teachers in my country's universities are not large. Therefore, increasing the introduction of talents returning from studying abroad is a better measure, and it is also considered to be an important part of building a high-level talent pool. Most of these groups are young teachers, and they are also the main force for postgraduate training. Relatively speaking, they have a relatively good international academic vision and international cooperation and communication skills. In addition, this group of young teachers is easy to establish scientific research cooperation and academic exchanges with their foreign tutors, which is more conducive to promoting the internationalization of graduate education and is the backbone of cultivating innovative graduate students.

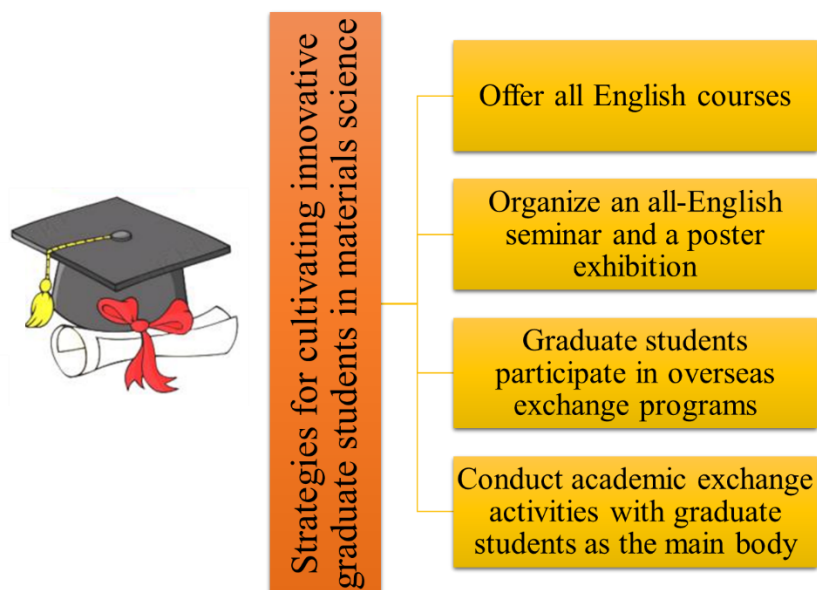


Figure 1 Strategies for cultivating innovative graduate students in materials science

Therefore, this article focuses on the new model of the international tutor assistance system for cultivating innovative graduate students, and further explores the influence of the international tutor assistance system on the improvement of graduate students' innovative ability based on the traditional "one-to-one" tutor system. The purpose of adopting the international tutor assistant system to train graduate students is to create an international teaching atmosphere, build an international teaching platform, and enhance the ability and international competitiveness of graduate students to conduct academic exchanges with foreign scholars [13-15]. At present, in the mode of cultivating innovative graduate students with the domestic tutor-based and international tutor-assisted system, and strategies for cultivating innovative graduate students in materials science are shown in Figure 1, the international education system that has been carried out includes:

(1) Offer all English courses. Professional courses are the foundation of postgraduate education, and offering professional courses taught in English is a necessary way to create an international teaching environment [5]. Beginning in 2012, after fully investigating the content, teaching mode, and curriculum concepts of materials subject courses of internationally renowned universities, and combining with the characteristics of the disciplines of the Institute of Materials Science and Technology, it has successively opened more than a dozen English courses, such as "Modern Material Analysis Methods", "Functional Materials Science", "Inorganic Nonmetallic Materials Science" and "Materials Engineering Fundamentals", etc. In addition to the above-mentioned optional English courses, the college also offers short semester courses taught by international tutors, so that graduate students can have direct contact with international classrooms, feel the atmosphere of international teaching, and enhance their academic communication and expression skills with foreign experts.

(2) Organize an all-English material science seminar and a poster exhibition of academic achievements. The academic exchange meeting is a new way of talent training in graduate education, which can help graduate students understand the cutting-edge knowledge of materials disciplines, master advanced research methods, cultivate innovative awareness, enhance

interdisciplinary capabilities, and help improve the quality of talent training [16-19]. Through the holding of the "Academic Summit Forum of the School of Materials Science and Technology", the majority of graduate students have obtained a valuable opportunity for face-to-face two-way exchanges with high-level scholars in the field of materials. The display of high-level scientific research work has also greatly broadened the international academic horizons of graduate students, improved their innovative skills, and promoted the further internationalization of graduate training. In addition, the training of the all-English academic achievements' poster exhibition has improved the academic exchange and presentation level of graduate students.

(3) Graduate students participate in overseas exchange programs. The college maintains extensive academic exchanges and friendly exchanges with universities, companies, and research institutes in the United States, Germany, Britain, Australia and other countries, and has established various forms of cooperative education relations, which is a good way to explore the training model of international engineering and technical talents. Communication platform. Graduate students of our school can apply for postgraduate exchange programs, course projects, overseas study internships, etc., with a short-term 4-week or long-term one-year exchange mode. The schools to choose from include Florida State University, the University of California, Los Angeles, and Kentucky. University, University of Houston, Central University of Japan, Chonbuk National University of Korea, University of Oulu in Finland, University of Oulu, Germany, etc. More than 30 universities or research institutes, such as the EU Erasmus Mundus Program-Excellent Analytical Chemist Joint Master Program (University of Tartu, Estonia) and other types of exchange programs support students to study in overseas universities and participate in innovative activities and provide graduate students with opportunities to directly learn and communicate with foreign tutors.

(4) Conduct academic exchange activities with graduate students as the main body. Our school has established joint academic forums with many foreign universities and research institutions. Every year, dozens of professors from different countries visit our school, participate in academic forums, and provide short-term courses for our school's undergraduates and graduate students. For example, the Liverpool John Moores University online conference held in November 2020 focuses on the theme of sustainable material development in the United Nations, allowing student representatives to have dialogue with foreign tutors from partner universities abroad, and cultivate students to become active, responsible, and professional. Stronger innovative materials science talents.

In general, the international tutor assistance system's model for cultivating innovative graduate students achieves cross-disciplinary and cross-professional open cooperation in terms of teaching content and scientific research projects. It provides opportunities for postgraduate students to communicate or even cooperate with foreign tutors during their studies. The innovative thinking and international innovation ability of graduate students escort the cultivation of international innovation ability of graduate students and realize the purpose of cultivating high-quality materials innovative talents. To establish a competitive, international and diversified talent team with a sense of belonging.

4. AN EXAMPLE ANALYSIS OF THE INTERNATIONAL TUTOR-ASSISTED SYSTEM TEACHING MODEL FOR CULTIVATING INNOVATIVE MATERIALS SCIENCE GRADUATE STUDENTS

With the development of my country's higher education, the domestic academic level has improved significantly, and the international advanced education, scientific research and teaching

methods have been further used for reference, and the University of Shanghai for Science and Technology has implemented an international joint training model. Participating in international joint training can not only broaden students' scientific research thinking, but also cultivate students' international vision. Every year, the School of Materials and Chemistry of the University of Shanghai for Science and Technology will select outstanding students to study and exchange research in world-class universities such as Chonbuk National University. In the process of participating in learning and scientific research, on the basis of full investigation of the curriculum system and teaching mode of Chonbuk National University, the University of Shanghai for Science and Technology draws on the curriculum content, teaching philosophy and training methods of scientific research personnel of Chonbuk National University. "According to the aptitude" has created a unique talent training system with domestic tutors as the mainstay and international tutors as the supplement with a new set of teaching ideas and research personnel training methods. Students engaged in international exchanges have received more comprehensive scientific research experimental training and have also been exposed to the latest and most cutting-edge scientific research information. In addition, they also participated in various top academic conferences and exchanged ideas with world-class scholars. They established a positive academic attitude, created a good academic atmosphere, increased their knowledge, and enriched their minds. Laid a solid foundation. Through a series of teaching innovations, the quality of the courses and the degree of internationalization have been improved, the students' academic communication ability has been enhanced, the students' international thinking has been cultivated, and the academic quality of the students has been comprehensively improved. Relying on the scientific research platform, advanced equipment and scientific research guidance of University of Shanghai for Science and Technology and Chonbuk National University, students have made brilliant achievements in scientific research and published many SCI papers.

The following analyzes an example of cultivating innovative graduate students under the assistance of international tutors to illustrate the advantages of the international joint training model. This case is a graduate student named Zhao Kun. It has undergone postgraduate study, under the guidance of Professor Yu Dengguang and Professor Kim from Chonbuk National University, using advanced synthesis technology, combined with the special three-layer concentric spinneret of this research group to prepare the function Chemical nanofiber membrane, this nanofiber membrane has a good photocatalytic degradation effect on antibiotics.

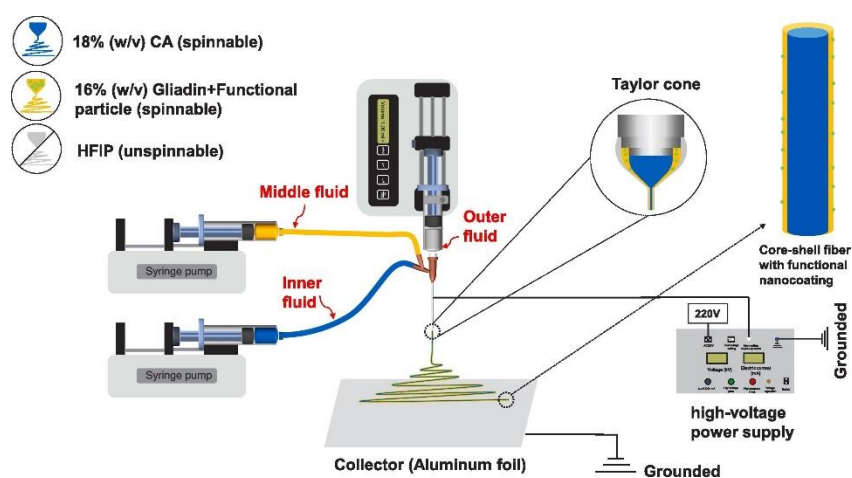


Figure 2 Schematic diagram of the modified three-stage coaxial classic spinning process.

First, he conducted a large amount of literature research, prepared β -FeOOH, used the modified secondary coaxial electrospinning technology to explore the spinnable window of cellulose acetate and Gliadin, and used dopamine on the surface of the nanofiber membrane on a secondary basis. Modified with β -FeOOH. Adopt soaking method and heat treatment method to coat polydopamine adhesive coating on the surface of cellulose acetate fiber. Under the joint guidance of the two professors, he further used a higher concentration of cellulose acetate solution on the basis of the theory that "non-spinning solvent as the outermost working fluid can prepare functional core-sheath fibers with a thinner nano-coating" As the core layer working fluid, it plays a role of mechanical support in the core sheath fiber; using adhesive Gliadin solution, doped with functional particles as the middle layer working fluid, minimize the flow rate of the middle layer working fluid during the electrospinning process, Make the fiber have a thinner coating and load functional particles; use pure solvent as the sheath working fluid to reduce the clogging phenomenon in the electrospinning process, so that the three-stage electrospinning process can be carried out smoothly. Using advanced modified tertiary coaxial electrospinning technology (as shown in the Figure 2), a functionalized nanofiber membrane is prepared. The functional particles are firmly loaded on the surface of the fiber without being completely covered by the polymer layer. The functional particles can be fully Take advantage of the large specific surface area of electrospun fibers to play a role [2].

In addition, the effects of different pH values, different functional particles, time and different initial concentrations on the adsorption and photocatalytic capabilities were also explored. It is found that β -FeOOH has a certain adsorption and photocatalytic degradation effect on doxycycline hydrochloride. The adsorption effect of nanofiber membrane is the best when the pH value is 10, and the photocatalytic effect of nanofiber membrane is the best when the pH value is 6. The adsorption equilibrium is reached after h, and the photocatalytic equilibrium is reached after 5 h of photocatalysis. Adding a certain amount of H₂O₂ can improve the photocatalytic degradation efficiency. The formation of β -FeOOH/TiO₂ heterostructure makes the electron-hole pair effective separation and greatly enhances To improve the photocatalytic degradation of drugs, the relative energy band potential of the two materials and good electron and hole conductivity are the key to the photocatalytic degradation of drugs by composite nanoparticles. This kind of functional film has a certain degree of adsorption and good photodegradability for antibiotics in water bodies, and shows a high potential for being widely used in water bodies to degrade antibiotics in the future. With the help of the scientific research platforms of the University of Shanghai for Science and Technology and Chonbuk University in South Korea, the final paper was published in the regional high-level magazine Chemical Engineering Journal.

5. CONCLUSION

In order to lead the world in technological innovation, my country must discover talents in innovative practice, cultivate talents in innovative activities, and condense talents in innovative undertakings. It must vigorously cultivate innovative scientific and technological talents with large scale, reasonable structure, and excellent quality. This article explores the important role of international tutors in cultivating innovative graduate students in materials science through the practice of domestic tutor-based and international tutor-assisted teaching mode, explores new graduate training models that meet national requirements, and cultivates an internationally forward-looking model for the country new era graduate students with vision and interdisciplinary understanding.

REFERENCE

- [1] Yanan Liu, Wanli He, Shiri Guo, Wenhui Zhou and Dengguang Yu. A Whole-Process Innovative Education on Undergraduate Students Based on Scientific Investigations. 6th Annual International Conference on Social Science and Contemporary Humanity, 2021, 517, 271-275.
- [2] Kun Zhao, Zi-Han Lu, Ping Zhao, Shi-Xiong Kang, Yao-Yao Yang, Deng-Guang Yu. Modified tri-axial electrospun functional core-shell nanofibrous membranes for natural photodegradation of antibiotics. *Chemical Engineering Journal*, 2021, 425, 131455.
- [3] Yu DG, Lv H. Preface-striding into nano drug delivery. *Current Drug Delivery*, 2022, 19(1), 1-3.
- [4] Zhou K, Wang M, Zhou Y, Sun M, Xie Y, Yu DG. Comparisons of antibacterial performances between electrospun polymer@drug nanohybrids with drug-polymer nanocomposites. *Adv. Compos. Hybrid Mater.* 2021, 4. Doi: 10.1007/s42114-021-00389-9
- [5] He, H.; Wu, M.; Zhu, J.; Yang, Y.; Ge, R.; Yu, D.G. Engineered spindles of little molecules around electrospun nanofibers for biphasic drug release. *Adv. Fiber Mater.* 2021, 3, DOI : 10.1007/s42765-021-00112-9
- [6] Xu, H.; Xu, X.; Li, S.; Song, W.-L.; Yu, D.-G.; Annie Bligh, S.W. The effect of drug heterogeneous distributions within core-sheath nanostructures on its sustained release profiles. *Biomolecules* 2021, 11, 1330. Doi: 10.3390/biom11091330
- [7] Hou J, Yang Y, Yu DG, Chen Z, Wang K, Liu Y and Williams GR 2021. Multifunctional fabrics finished using electrospayed hybrid Janus particles containing nanocatalysts. *Chem. Eng. J.* 411, 128474. Doi:10.1016/j.cej.2021.128474
- [8] Lv H, Yu DG, Wang M and Ning T 2021. Nanofabrication of Janus fibers through side-by-side electrospinning - A mini review. *Mater. Highlight.* 2, 18-22. Doi:10.2991/mathi.k.210212.001
- [9] Zhang, X.; Guo, S.; Qin, Y., Li, C. Functional electrospun nanocomposites for efficient oxygen reduction reaction. *Chem. Res. Chinese Universities*, 2021, 37(3), 379-393. <https://doi.org/10.1007/s40242-021-1123-5>
- [10] Liu, Y.; Chen, X.; Yu, D.G.; Liu, H.; Liu, Y.; Liu, P. Electrospun PVP-core/PHBV-shell nanofibers to eliminate tailing off for an improved sustained release of curcumin. *Mol. Pharm.* 2021, 18(11), 4170-4178. 10.1021/acs.molpharmaceut.1c00559
- [11] Liu, X.; Xu, H.; Zhang, M.; Yu, D.G. Electrospun medicated nanofibers for wound healing-Review. *Membranes* 2021, 11, 770. <https://doi.org/10.3390/membranes11100770635>.
- [12] Wang M, Hou J, Yu DG, Li S, Zhu J and Chen Z 2020. Electrospun tri-layer nanodepots for sustained release of acyclovir. *J. Alloy. Compd.* 846, 156471. Doi:10.1016/j.jallcom.2020.156471
- [13] Wang M, Li D, Li J, Li S, Chen Z, Yu DG, Liu Z and Guo JZ 2020. Electrospun Janus zein-PVP nanofibers provide a two-stage controlled release of poorly water-soluble drugs. *Mater. Des.* 196, 109075. Doi: 10.1016/j.matdes.2020.109075
- [14] Yu DG, Wang M, Ge R. Strategies for sustained drug release from electrospun multi-layer nanostructures. *WIREs Nanomedicine and Nanobiotechnology*, 2022, 14.
- [15] Kang S, Hou S, Chen X, Yu DG, Wang L, Li X and Williams GR 2020. Energy-saving

- electrospinning with a concentric Teflon-core rod spinneret to create medicated nanofibers. *Polymers* 12, 2421. Doi:10.3390/polym12102421
- [16] Wang K, Wen HF, Yu DG, Yang YY and Zhang DF 2018. Electrospayed hydrophilic nanocomposites coated with shellac for colon-specific delayed drug delivery. *Mater. Des.* 143, 248-255. Doi:10.1016/j.matdes.2018.02.016
- [17] Yu DG 2021. Preface-bettering drug delivery knowledge from pharmaceutical techniques and excipients. *Curr. Drug Deliv.* 18, 2-3. Doi:10.2174/156720181801201203091653
- [18] Aidana Y, Wang YB, Li J, Chang SY, Wang K and Yu DG 2021. Fast dissolution electrospun medicated nanofibers for effective delivery of poorly water soluble drugs. *Curr. Drug Deliv.* 18, 4-21. Doi:10.2174/1567201818666210215110359
- [19] Yu DG 2021. Preface-bettering drug delivery knowledge from pharmaceutical techniques and excipients. *Curr. Drug Deliv.* 18, 2-3. Doi:10.2174/156720181801201203091653